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REFINED COMPUTER SIMULATION OF LOSS IN QUANTUM-BASED SATELLITE CHANNEL

Abstract

The era of the second quantum revolution has begun. Since more and more commercial products are available on the market, quantum-based communication is no longer confined to the world of research laboratories. There are a growing number of quantum random number generators and quantum key distribution systems available as new startups join the market every year. However up until recently the distance at witch secret quantum keys could be transmitted was limited to a few hundred kilometers.

Previous, theoretical calculations and proof of concept experiments indicated that quantum-based satellite channels might have lower losses than conventional optic fiber channels. In August of 2016, the world's first quantum communications satellite has been launched in China. With this, the Chinese QuESS satellite became the first that realized a space-earth quantum downlink using ultra weak laser signals. In September 2017, researchers performed a secure video call between China and Austria at a record breaking distance. The security of the communication was based on the key exchanged via the quantum satellite.

In our previous works we analyzed the properties of a possible satellite-Earth quantum communication link by simulating a global, satellite based quantum key distribution (QKD) network. Our work is aimed at predicting losses in satellite-based quantum links under various geographic and weather conditions. To help this analysis, we have developed a Java Swing simulation platform named Quantum Satellite Communication Simulator.

Using the reported parameters in the QuESS experiment we recently validated and refined our previous model. In this paper we introduce the changes made to our simulation software. These changes include new aerosol profiles that are based on different geographic conditions and a new geometric optics based approximation of beam wander. Our results show that most calculations yield results in the same order of magnitude as the measured values.